

2-8.

19. The apparatus of claim 9 wherein the image processing system comprises a human-machine interface.

20. (Amended) An article of manufacture comprising a storage medium for storing one or more programs for detecting an object of interest in an image processing system, wherein the one or more programs when executed by a processor implement the steps of:

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generating a difference image;

10 segmenting the difference image into a plurality of regions, wherein the difference image is segmented into a plurality of regions such that each of the regions are bounded by one or more lines passing through the entire image;

identifying one or more silhouette candidates in at least a subset of the regions; and

detecting the object of interest based at least in part on the identified silhouettes

REMARKS

The present application was filed on November 24, 1999 with claims 1-20. Claims 1 through 20 are presently pending in the above-identified patent application. Claims 1, 9 and 20 are proposed to be amended herein.

The present invention is directed to a method and apparatus for detection of persons or other objects of interest in a video signal or other type of image signal. In accordance with an illustrative embodiment of the invention, a processing system generates, e.g., a threshold difference image by processing an image signal received from a camera. The difference image is then segmented into regions bounded by

lines, such as vertical lines, passing through the image, and silhouette candidates are identified in one or more of the regions. Tensor voting is used to determine saliency values and corresponding tangents for each of the silhouette candidates, and the resulting values and tangents are used to detect the object of interest.

In the Office Action, the Examiner rejected Claims 1-3, 5, 9-11, 13 and 18-20 under 35 U.S.C. §102(e) as being anticipated by Courtney (United States Patent No. 5,969,755). The Examiner also rejected Claims 4 and 12 under 35 U.S.C. §103(a) as being unpatentable over Courtney, rejected Claims 6 and 14 under 35 U.S.C. §103(a) as being unpatentable over Courtney, in further view of the article entitled "Grouping into Regions, Curves, and Junctions" by Lee et al. and rejected Claims 7, 8, and 15-17 under 35 U.S.C. §103(a) as being unpatentable over Courtney, in further view of Gibbon (E.P. Patent No. 0 635 983 A2).

Independent Claims 1, 9, and 20

The Examiner rejected independent Claims 1, 9, and 20 under 35 U.S.C. §102(e) as being anticipated by Courtney.

The Examiner asserts that, referring to claim 1,
5 Courtney discloses a method for detecting an object of interest in an image processing system. The Examiner further assert that Courtney discloses the step of segmenting the difference image into a plurality of regions (citing col. 6, lines 27-31 and Figure 7f).

10 Each of the independent claims have been amended to emphasize that the difference image is segmented into a plurality of regions such that each of the regions are bounded

by one or more "lines passing through the entire image." The Examiner has previously considered this limitation in rejecting claims 4 and 12 that specify regions bounded by one or more vertical lines. With regard to claims 4 and 12, the Examiner
5 recognized in paragraph 2 of the Office Action that Courtney does not explicitly state that the vertical lines pass through the entire image. The Examiner asserts, however, that it would have been obvious to extend the vertical lines of the "bounding box" so that it passes through the entire image in order to
10 separate the plurality of regions for easy detection of the object of interest.

Applicant submits, however, that it would not be obvious to a person of ordinary skill in the art to extend the "bounding box" of Courtney so that it passes through the entire
15 image, because such an extension would cause overlapping boxes and more than one object to be present in the bounding box. The present invention recognizes that more than one object can be present in the bounded region and can further segment the image to verify the presence of the object of interest in the region.
20 If the verification step fails, i.e., the silhouette does not have the right saliency value, the algorithm reports no object of interest found in that region.

Thus, Courtney does not disclose or suggest "segmenting the difference image into a plurality of regions,
25 wherein the difference image is segmented into a plurality of regions such that each of the regions are bounded by one or more lines passing through the entire image," as required by each of the independent claims as amended.

Additional Cited References

The Examiner has also cited Lee et al., "Grouping into Regions, Curves, and Junctions" for its disclosure of the determination of saliency values using tensor voting. Lee et al. does not disclose or suggest "segmenting the difference image into a plurality of regions, wherein the difference image is segmented into a plurality of regions such that each of the regions are bounded by one or more lines passing through the entire image," as required by each of the independent claims as amended.

The Examiner has also cited Gibbon (E.P. Patent No. 0 635 983 A2) for its disclosure of the step of detecting a neck position of a moving person by analyzing the sum of x-components of tangents along a corresponding silhouette. Gibbon does not disclose or suggest "segmenting the difference image into a plurality of regions, wherein the difference image is segmented into a plurality of regions such that each of the regions are bounded by one or more lines passing through the entire image," as required by each of the independent claims as amended.

Dependent Claims 2-8 and 10-19

The Examiner rejected dependent Claims 2-3, 5, 10-11, 13 and 18-19 under 35 U.S.C. Section 102(e) as being anticipated by Courtney (United States Patent No. 5,969,755), rejected dependent Claims 4 and 12 under 35 U.S.C. §103(a) as being unpatentable over Courtney, rejected Claims 6 and 14 under 35 U.S.C. §103(a) as being unpatentable over Courtney, in further view of the article entitled "Grouping into Regions, Curves, and Junctions" by Lee et al. and rejected Claims 7, 8, and 15-17 under 35 U.S.C. §103(a) as being unpatentable over Courtney, in further view of Gibbon (E.P. Patent No. 0 635 983 A2).

Claims 2-8 and 10-19 are dependent on independent Claims 1 and 9, respectively, and are therefore patentably distinguished over Courtney, Lee, and Gibbon (alone or in any combination) because of their dependency from amended independent Claims 1 and 9 for the reasons set forth above, as well as other elements these claims add in combination to their base claim.

In view of the foregoing, Applicant respectfully submits that the present application is in condition for allowance.

Early and favorable action is earnestly solicited.

Respectfully submitted,

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CERTIFICATE OF FACSIMILE TRANSMISSION

It is hereby certified that this correspondence is being deposited on the date indicated below with the U.S. Postal Service as first class mail addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

On January 27, 2003

By Kevin Mason

VERSION MARKED TO SHOW ALL CHANGES

IN THE CLAIMS:

Please amend the claims as indicated below:

5 1. (Amended) A method for detecting an object of interest
in an image processing system, the method comprising the steps
of:

generating a difference image;

10 segmenting the difference image into a plurality of
regions, wherein the difference image is segmented into a
plurality of regions such that each of the regions are bounded
by one or more lines passing through the entire image;

identifying one or more silhouette candidates in at
least a subset of the regions; and

15 detecting the object of interest based at least in
part on the identified silhouettes.

2. The method of claim 1 wherein the object of interest
comprises a moving person.

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3. The method of claim 1 wherein the difference image
comprises a thresholded difference image generated by taking a
difference between a first image and a second image and applying
binary thresholding to the resulting difference.

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4. The method of claim 1 wherein the difference image is
segmented into a plurality of regions such that each of the

regions are bounded by one or more vertical lines passing through the entire image.

5 5. The method of claim 1 wherein each of the regions of the image which includes a silhouette candidate includes only a single silhouette candidate.

10 6. The method of claim 1 further including the step of determining saliency values for each of the silhouette candidates using tensor voting.

15 7. The method of claim 2 further including the step of detecting a neck position of the moving person by analyzing a sum of x-components of tangents along a corresponding silhouette.

20 8. The method of claim 7 further including the step of utilizing the detected neck position to determine at least one of a head position and a head size for the moving person.

25 9. (Amended) An apparatus for detecting an object of interest in an image processing system, the apparatus comprising:

 a camera; and

30 a processor coupled to the camera and operative (i) to generate a difference image from a signal received from the camera; (ii) to segment the difference image into a plurality of regions, wherein the difference image is segmented into a plurality of regions such that each of the regions are bounded by one or more lines passing through the entire image; (iii) to

identify one or more silhouette candidates in at least a subset of the regions; and (iv) to detect the object of interest based at least in part on the identified silhouettes.

5 10. The apparatus of claim 9 wherein the object of interest comprises a moving person.

 11. The apparatus of claim 9 wherein the difference image comprises a thresholded difference image generated by taking a
10 difference between a first image and a second image and applying binary thresholding to the resulting difference.

 12. The apparatus of claim 9 wherein the difference image is segmented into a plurality of regions such that each of the
15 regions are bounded by one or more vertical lines passing through the entire image.

 13. The apparatus of claim 9 wherein each of the regions of the image which includes a silhouette candidate includes only
20 a single silhouette candidate.

 14. The apparatus of claim 9 wherein the processor is further operative to determine saliency values for each of the silhouette candidates using tensor voting.

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 15. The apparatus of claim 10 wherein the processor is further operative to detect a neck position of the moving person by analyzing a sum of x-components of tangents along a corresponding silhouette.

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16. The apparatus of claim 15 wherein the processor is further operative to utilize the detected neck position to determine at least one of a head position and a head size for the moving person.

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17. The apparatus of claim 9 wherein the image processing system comprises a video conferencing system.

18. The apparatus of claim 9 wherein the image processing system comprises a video surveillance system.

19. The apparatus of claim 9 wherein the image processing system comprises a human-machine interface.

15 20. (Amended) An article of manufacture comprising a storage medium for storing one or more programs for detecting an object of interest in an image processing system, wherein the one or more programs when executed by a processor implement the steps of:

20 generating a difference image;
segmenting the difference image into a plurality of regions, wherein the difference image is segmented into a plurality of regions such that each of the regions are bounded by one or more lines passing through the entire image;

25 identifying one or more silhouette candidates in at least a subset of the regions; and

detecting the object of interest based at least in part on the identified silhouettes.